

WHAT IS CLAIMED IS:

- 1 1. A method for controlling intake air of an internal
2 combustion engine, the engine having at least one combustion
3 chamber provided with intake means together with an intake
4 manifold provided with a throttle valve, wherein the opening and
5 closure timings of the intake means are adjustable entirely
6 independently from the crankshaft position to control the
7 amount of intake air supplied to the combustion chamber, the
8 method comprising:
9 providing a response adjustment to variable valve timing
10 control of the intake means for unthrottled intake air control.
- 1 2. The method as claimed in claim 1, wherein the step of
2 providing said response adjustment comprises:
3 providing an engine response performance during
4 unthrottled intake air control as much as an engine response
5 performance during throttled intake air control.
- 1 3. The method as claimed in claim 1, further comprising:
2 separating a first operation range for unthrottled intake air
3 control from a second operation range for throttled intake air
4 control;
5 varying valve timing of the intake means with the throttle
6 valve held in the neighborhood of the wide open throttle position
7 to perform throttled intake air control during said first operation
8 range; and
9 varying throttle valve position of the throttle valve with
10 valve timing of the intake means held to provide a valve opening
11 duration in the neighborhood of the minimum valve opening
12 duration.

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1 4. The method as claimed in claim 1, further comprising:
2 determining a first operation variable indicative of a target
3 intake air;
4 determining a second operation variable indicative of a
5 target valve timing based on said first operation variable;
6 wherein the step of providing said response adjustment
7 comprises:
8 processing said second operation variable to cause said
9 response adjustment.

1 5. A system for controlling intake air of an internal
2 combustion engine, the engine having at least one combustion
3 chamber provided with intake means together with an intake
4 manifold provided with a throttle valve, wherein the opening and
5 closure timings of the intake means are adjustable entirely
6 independently from the crankshaft position to control the
7 amount of intake air supplied to the combustion chamber, the
8 method comprising:
9 a control for a response adjustment to variable valve
10 timing control of the intake means for unthrottled intake air
11 control.

1 6. A system for controlling intake air of an internal
2 combustion engine, the engine having at least one combustion
3 chamber, the system comprising:
4 at least one intake valve provided for the combustion
5 chamber;
6 an electromagnetic driver operatively connected to each
7 intake valve for opening said intake valve;
8 an intake manifold with a throttle valve communicating
9 with each intake valve; and
10 sensors providing operation variables indicative of
11 operator torque request command and engine speed;

16 said control unit being operative to make a selection based
17 on said first operation parameter indicative of target intake air
18 between a first operation range for unthrottled intake air control
19 and a second operation range for throttled intake air control,
20 said first and second operation range being separated from each
21 other by a threshold value of target intake air at each of varying
22 values of engine speed, said threshold value increases as engine
23 speed increases,

24 said control unit being operative to vary, with valve
25 opening timing held in the neighborhood of the top dead center.
26 valve closure timing of said intake valve with said throttle valve
27 held in the neighborhood of the wide open throttle position to
28 perform throttled intake air control upon selection of said first
29 operation range, and vary throttle valve position of said throttle
30 valve with valve timing of said intake valve held to provide a
31 valve opening duration in the neighborhood of the minimum
32 valve opening duration that is variable with varying engine
33 speed,

34 *said control unit being operative to determine a second*
35 *operation parameter indicative of a target valve closure timing*
36 *of said intake valve based on said target intake air,*

37 said control unit being operative to provide a response
38 adjustment to said second operation parameter indicative of
39 said target closure timing to give a processed second operation
40 parameter, and

41 *said control unit being operative to control said*
42 *electromagnetic driver to cause said intake valve to close at*
43 *valve closure timing indicated by said processed second*
44 *operation parameter.*

- 1 7. A method for controlling of intake air of an internal
2 combustion engine, the engine having at least one combustion
3 chamber provided with intake means together with an intake
4 line having variable flow area dimensions, outside of the intake
5 means, determined by a throttle, wherein the opening and
6 closure timings of the intake means are adjustable entirely
7 independently from the crankshaft position to control the
8 amount of intake air supplied to the combustion chamber, the
9 method comprising:
- 10 determining a first operation parameter indicative of
11 target intake air;
- 12 determining a second operation parameter indicative of a
13 preliminary valve closure timing for unthrottled intake air
14 control;
- 15 processing said second operation parameter to provide a
16 response adjustment to give a processed second parameter;
- 17 varying the valve closure timing of the intake means to
18 close the intake means at a valve closure timing indicated by
19 said processed second operation variable.
- 1 8. A computer readable storage medium having stored
2 therein data representing instructions executable by a computer
3 to implement unthrottled control of intake air of an internal
4 combustion engine, the engine having at least one combustion
5 chamber provided with intake means, wherein the opening and
6 closing times of the intake means are adjustable entirely
7 independently from the crankshaft position to control the
8 amount of intake air supplied to the combustion chamber, the
9 computer readable storage medium comprising:
- 10 instructions for determining a first operation parameter
11 indicative of target intake air;
- 12 instructions for determining a second operation parameter
13 indicative of a preliminary valve closure timing for unthrottled

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14 intake air control;
15 instructions for processing said second operation
16 parameter to provide a response adjustment to give a processed
17 second parameter;
18 instructions for varying the valve closure timing of the
19 intake means to close the intake means at a valve closure timing
20 indicated by said processed second operation variable.

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